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Multivariate fingerprinting and kinetic analysis of quality stability in almond-fortified brown goat's milk yoghurt during storage

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Abstract: The quality evolution of almond brown goat's milk yoghurt (ABY) and commercial brown goat's milk yoghurt (CY) during refrigerated storage (4 °C, days 1–20) was investigated using an integrated multivariate and kinetic modelling approach. Sensory attributes, textural parameters (hardness, cohesiveness, viscosity, adhesiveness), acidity, viable cell counts, and 5-hydroxymethylfurfural (HMF) content were combined using principal component analysis (PCA) to establish a comprehensive quality fingerprint, which explained 90.7% of the total variance. ABY exhibited greater storage stability, with consistently higher hardness and sensory scores than CY. Kinetic modelling indicated slower deterioration of sensory quality and slower acidity development in ABY, accompanied by only a slight decline in viable cell counts (k = 0.029 d^{-1}). HMF accumulation and viable bacterial counts exhibited opposing temporal trends during storage, and HMF accumulation was generally lower in ABY. Hierarchical clustering further showed that ABY maintained higher standardised values for texture, sensory quality, and microbial viability throughout refrigerated storage. Overall, almond incorporation enhanced the storage stability and quality of brown goat's milk yoghurt, supporting its application in plant–dairy hybrid fermented products.

Keywords: brown goat's milk yoghurt; almond; kinetic modelling; multivariate fingerprinting; storage stability

The authors are fully responsible for both the content and the formal aspects of the Electronic Supplementary Material. No editorial adjustments were made.

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Electronic Supplementary Material

Supplementary Table S1. Sensory evaluation criteria used for almond brown goat yoghurt

Attribute	Evaluation criteria	Score
Flavour	strong caramel and almond flavour; harmonious sweet–sour taste; no off-flavour	18–25
	moderate caramel flavour with slight almond flavour	12–18
	weak caramel flavour	6–12
	off-flavour or unbalanced taste	0–6
Mouthfeel	smooth, creamy, no grittiness	18–25
	slight grittiness	12–18
	rough texture	6–12
	poor mouthfeel	0–6
Colour	uniform yellowish-brown colour characteristic of brown yoghurt	18–25
	uniform brown colour	12–18
	uneven light brown colour	6–12
	uneven colour without characteristic browning	0–6
Structure	uniform coagulum, moderate viscosity, no whey separation	18–25
	slight syneresis	12–18
	moderate syneresis	6–12
	severe syneresis	0–6